Ethnobotanical study of medicinal plants used against sickle cell anaemia in the eastern part of the Côte d'Ivoire

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Keywords: Ethnobotanical, Medicinal plants, Sickle cell anaemia, Côte d'Ivoire.

Publication date 31/07/2020, http://m.elewa.org/Journals/about-japs/

1 SUMMARY

An ethnobotanical survey was conducted to record the various plant families, species, and plant parts used to manage sickle cell disease in the Indenié-Djouablin region eastern Côte d'Ivoire. Nine traditional healers aged 36 to 67 years old were selected in six different villages according to their reputation in knowledge of traditional medicine, their availability and their willingness to share information. A total of 26 species of plants belonging to 20 families were reported to have antisickling activity. Eleven (11) different medication recipes were composed from these 26 species of plants ((*Afromonum melegueta* (Roscoe) *K. Schum.*, *Xylopia aethiopica*) mainly). The main plant parts used were stem bark (38%) followed by fruit (18%) and seeds (18%). The majority of the main plants recorded (84.61 %) were wild. From the recorded plants, 65.38 % were trees and 23.07 % shrubs. Most remedies (82%) were made up by decoction and were employed orally (54 %) or by enema (32 %). The potential anti-sickling activity of the plant species recorded during this study could be the effect of alkaloids, polyphenols, quinones and terpenoids compounds found during the phytochemical screening of the 26 plants species.

2 INTRODUCTION

Sickle cell disease (SCD) or sickle cell anaemia (SCA) is an autosomal recessive genetic blood inherited disorder. SCA results from a point mutation in the β-globin gene that leads to the substitution of a hydrophilic glutamic acid by a hydrophobic Valine residue, at the sixth position of the β-chain of haemoglobin molecule. This mutation leads to the transformation of Haemoglobin A (HbA) to Haemoglobin S (HbS) (Bindon, 2004). Under hypoxic situation, homozygous individuals could suffer from pains due to vaso-occlusive crises, hemolytic anaemia and increased sensitivity to infections (Galacteros, 1997; Girot *et al.*, 2003, Thuret *et al.*, 2010). In Côte d'Ivoire, the magnitude of this disease results in a prevalence rate of about 14% of the total population and 2% representing the severe forms (Tolo *et al.*, 2010; Sawadogo *et al.*,

2014). In Côte d'Ivoire, as in other developing countries, the difficulties of accessing primary health care and the reduced financial means, leads 80% of the population to use medicinal plants for the treatment of different diseases (Ngbolua *et al.*, 2011 a; b). Despite the reliance on plants for the treatment of human health diseases in Côte d'Ivoire, there have been no empirical studies to document the indigenous knowledge and specific plant species used by traditional healers to treat sickle cell anaemia. This study was initiated in order to identify the medicinal plants that are used by traditional healers in the management of Sickle cell disease in South Eastern Côte d'Ivoire.

3 MATERIEL ET METHODES

3.1 Study area: The area studied was in the east of Côte d'Ivoire in the Indenié-Djouablin region (6° 43' 47" North and 3° 29' 47" West). The survey covered six villages: N'gra, Kouakou-Dramankro, Abro-Namue, Adaou, Amoriakro, and Ebakro. The studied area was bounded to the north by the region of Gontougo and Iffou to the west by the region of N'Zi, to the south by the region of Me and to the east by the Republic of Ghana. The region covers an area of 6,919.55 km^2. The recent General Census of Population and Housing recorded a population of about 700,000 inhabitants in Indenié-Djouablin (Rgph, 2014). The survey's area is located in the Guinean part of Côte d'Ivoire characterized by the densest water system and forest (Rgph, 2014). With a sub-equatorial climate, the studied area has a culturable area favourable for food and industrial crops. The population of Indenié-Djouablin is characterized by the presence of several large ethnic groups (Agni, Malinkés, Baoulés, N'Zima, Abourés,). The rest of the population is made up of the other ethnic groups in Côte d'Ivoire and the allogenous who came mainly from countries in the sub-region (Burkina Faso, Ghana, Benin, Togo and Niger).

3.2 Vegetable and technical material: The twenty-eight main plants species from the survey represented the vegetable material. Guided by the healers, classic material such as knife and machete were used to collect some plants samples in order to conduct the chemical study and to build up a collection of dried plants for future reference.

3.2 Methods

3.2.1 Ethno-medicinal survey: The information summarized in the present paper was compiled from 6 villages in the Indenié-Djouablin regions (Figure 1). The methodology followed in the field surveys is based on Fujita *et al.*, (1995). The data was collected through semi-structured interviews performed with local people (Martin, 1995). After explaining the purpose of the visit, a questionnaire in French was proposed. If the French level of the respondent was low, the questionnaire was translated into the local language. A total of 09 people were surveyed. The informants were questioned two times, which helped checking the information already collected. Information gathered on various data such as local names, plant part used, therapeutic effect, diseases treated, methods of preparation, methods of administration, duration of treatment and traditional cultivation techniques were obtained and recorded. Questions about the traditional healers' personal information were also asked. Field trips were conducted with the interviewees to collect specimens of the plants. A photographic archive of the observed species was created to help the identification. The collected samples were identified at the National Floristic Center (C.N.F.), by their scientific and family name and their botanical characteristics. All the results were listed Table 2 and 3. The card was made with the software ArcGIS 10.5

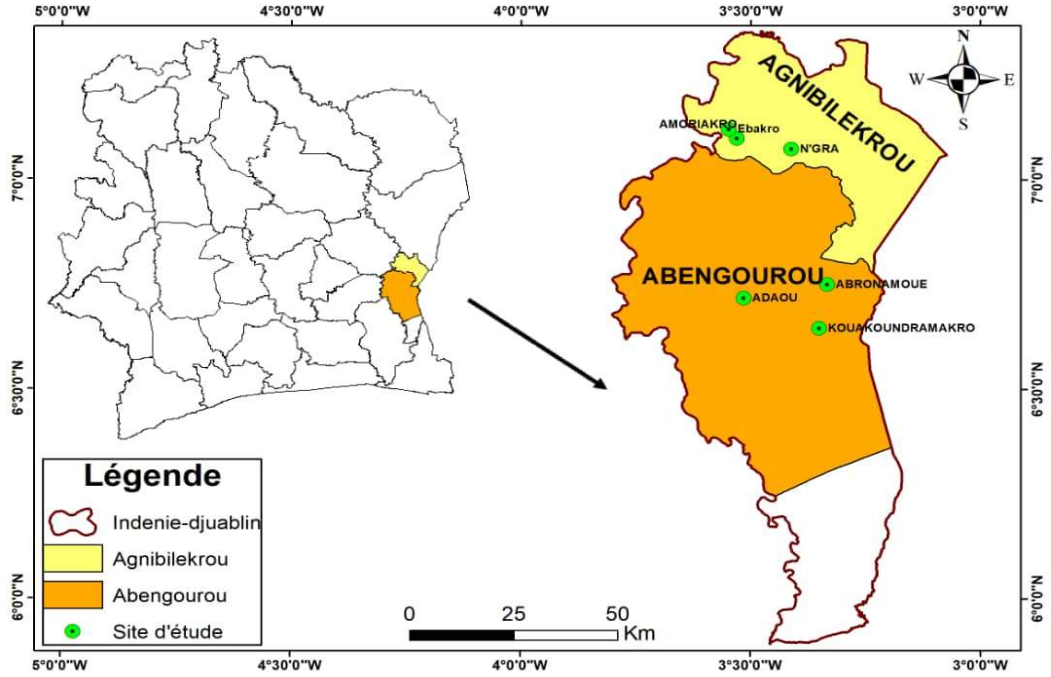

Figure 1: Geographical location of the study area (software ArcGIS 10.5)

3.2.2 Preparation of the plant extracts

3.2.2.1 Getting powder from each plant: The different parts of the collected plants were washed, cut and dried at room temperature (25-30°C) in the Biochemistry Laboratory at University Félix Houphouet-Boigny, during 3 weeks. The dried plant material was pulverized, using an electric crusher and used to prepare aqueous extract and hydro-ethanolic extract.

3.2.2.2 Preparation of Aqueous Extract (AE) and hydro-ethanol extract (HEE): Zirihi *et al.*, (2003) was used for the preparation of both extracts

3.2.3 Characterization of the chemical groups: Major groups of secondary metabolites such as sterols, polyterpenes, alkaloids, tannins, polyphenols, flavonoids, quinones, and saponins were characterized by classical methods described by Nemlin and Brunel, (1995) and Békro *et al.*, (2007).

Table1: Reagents and tests of characterization of the chemical groups

Secondary metabolites	Reagents	Reaction indicating that the test is positive
Alkaloids	Dragendorff	Precipitate or orange colouring
Flavonoids	Cyanidine	Reddish-brown precipitate
Polyphenols	Ferric chloride	Heat then pink-orange or purplish colouring
Quinones	Bornstraegen	Blackish-blue or green ± dark colouring
Saponosides	Foam Test	Persistent foam, higher than 1cm
Sterols and Polyterpenes	Liebermann	Crimson or purple ring, changing blue then green
Tannins	Stiasny	Catechic : precipitate in large flakes Gallic : blue-black deep colouring

4 RESULTS AND DISCUSSION

4.1 Demographic profile of traditional medicine practitioners: During this ethnomedicinal study conducted in Indenié-Djouablin region of eastern part of Côte-d'Ivoire, 9 traditional healers were interviewed. Native of 6 villages, the traditional healers have collaborated in this study by providing information on antisickling plants they were using to treat people. All the informants knew and described perfectly SCD's symptoms: vaso-occlusive crisis, frequent anaemia, yellow eyes, and retarded growth. One (1) man and eight (8) women were interviewed. The oldest person of these healers was a woman about 70 years old and the youngest was a man about 39 years old. The interviewed that were between 30 and 50 years of age represented 44 % and those between 50 and 85 years old represented 56 %. Only 17% of the respondents could read. The remaining 83% never attended school.

4.2 Ethnobotanical characteristics of the studied plants: The study made it possible to identify 26 species of plants used in traditional medicine to treat sickle cell anaemia (Table 2). These 26 species of plants were composed of 20 family. Five (5) families: Annonaceae, Apocynaceae, Bignoniaceae, Rutaceae and Rubiaceae were the most used. The most used species by the tradiditionnal hales were were *Afromonum melegueta* (Roscoe) *K. Schum*. (17, 94 %), *Xylopia aethiopica* (15. 38 0%), *Ceiba pentandra* (4.8 %) and *Nauclea latifolia* (4.8 %). This result was not observed in other parts areas of Côte-d'Ivoire. N'guessan *et al.,* (2009), working on the phytochemical screening of some Ivorian medicinal plants used in the department of Agboville (Côte-d'Ivoire), did not mention any plants species that have antisickling activity. As for, Ouattara *et al*., (2016) investigating the floristic diversity and uses of medicinal plants in the Sudanese area of the northwest of the Côte d'Ivoire, he noted that 3 plants species representing 5.7% of the total plants, were reported to be effective in the treatment of sickle cell anaemia. Two (02) of the 3 plants species, *Khaya senegalensis* and *Zanthoxylum zanthoxyloides* were reported in the present study were of the same genus as the specie *Zanthoxylum leprieuri* and *Zanthoxylum gilletii*. This variability in the results would be due to the specific topic, which is the ethnobotanical survey of the plant used against sickle cell disease in the present survey. In other western parts of Africa, the survey of **Gbadamosi, (2015)** was made among 20 traditional medicine practitioners. In this study, 60 plant species from 32 families were identified to fight against SCD. Among the most frequently. Were *Afromonum melegueta* (Rosc) K. Schum. (8%), *Xylopia aethiopica* (Dunal) A. Rich. (13%), and *Zanthoxylum zanthoxyloides* (Lam.) Zepern and Timler (11%) In the present study representing the most divulged species with their percentage frequency were *Afromonum melegueta* (Roscoe) K. Schum. (17. 94 %), *Xylopia aethiopica* (Dunal) A. Rich. (15. 38 0%) and *Zanthoxylum zanthoxyloides* (Lam.) Zepern and Timler (2. 43 %). *Zanthoxylum leprieuri, zanthoxylum gilletii, Khaya senegalensis* and *Solanum torvum* representing 4. 8% were found having the same genus and family that some plants from Gbadamosi, (2015). Finally, 37% of the plant species listed in the present study were present in the list of plants of the investigation of Gbadamosi, (2015). Working on a review of Medicinal Plants used for the Treatment of Sickle Cell Disease in the Democratic Republic of Congo, Mpiana *et al.,* (2012) found 53 plant species growing spontaneously which were prescribed by traditional healers for their potential against sickle cell disease. This different results would be due to the use of different methods of investigation and different number of informants

4.3 Some traditional recipes used for the management of sickle cell disease: Eleven (11) recipes were made up from the 26 species that were reported to be effective in the management of sickle cell disorder in the study area (Table 3). Ten (10) multi-plants recipes representing 91 % are mainly used compared

to the nine percent (9 %) mono-plant recipes. However, Gbadamosi, *et al.,* (2012) has highlighted the efficacy and steady antisickling activity of mono-plant recipe composed of *Phyllanthus amarus* Schumach. & Thonn. The patient could take an advantage by using the monospecific receipts because the combination of several plants recipes could sometimes be dangerous. In Africa, about 30 % of fatal accidents are caused by mixtures (Béné *et al.,* 2016).

4.4 preparation and administration of traditional medicines: All the plants parts were used. The stem (38 %) was the most used followed by fruit (18 %), seed (18 %), leaf (17 %) and roots (9 %). This result is different from that of Gbadamosi, (2015). This author showed that the leaves were the most used in Oyo State in Nigeria (32%), followed by root (24%), fruit (15%), bark (15%), seed (7%), rhizome (3%) and bulb (4%). Amujoyegbe *et al.,* (2016) also has determined that the leaves are first used (69. 10%) followed by the root (17. 98%) in Southern Nigeria. Both these two last authors had the same trend according to the percentage of the plant parts used. The difference between those results and this present study could be explained by the study area. The study of the former authors were both located in the same country, which was different from Côte d'Ivoire. Also, using the leaves has its advantage. As Poffenberger *et al.*, (1992) wrote, 50% of the leaves could be harvested without affecting the survival of the plant. The canary, the flat stone, the pebble, the mortar and the pestle are used to prepare the medication recipes. The decoction (82 %) is the most used method of preparation. This result looks similar to Amujoyegbe *et al.,* (2016) and Ouattara (2006) who explained that the decoction is only one method use in the department of Divo. The most common way used to administer the medicines is orally (54%) followed by enema (32 %) and 14% by cutaneous way.

Table 2: Plant characteristics obtained in the survey

N°	Scientific names of plants	Family	Morphology	State of plants	Other therapeutic Practices
1	***Adenia lobata (JACQ)***	Passifloraceae	Tree	Wild	Malaria; anti-inflammatory; Infection
2	***Afromonum melegueta (K.SCHUM)***	Zingiberacea	Grass	Wild	Infection
3	***Alstonia boonei* (De Wild)**	Apocynaceae	Tree	Wild	anaemia; antihypertensive; Malaria; anti-inflammatory
4	***Annona senegalensis (PERS)***	Annonaceae	Tree	Wild	Infection; anaemia; Malaria; pain
5	***Anthocleista djalonensis (AFZEL)***	Loganiaceae	Tree	Wild	Malaria; anti-inflammatory; Infection
6	***Blighia sapida (K.D. KOENIG)***	Sapindaceae	Tree	Wild	Anaemia; infection; Pain
7	***Casia sieberiana (DC)***	Caesalpiniaceae	Tree	Wild	Anaemia; Malaria; infection
8	***Ceiba pentandra (L.GAERTN)***	Bonbacaceae	Tree	Wild	Anaemia; Malaria; infection; typhoide fever
9	***Distemonanthus benthamianus (BAILL)***	Caesalminiaceae	Tree	Wild	Sexual infection,anaemia; antihypertensive
10	***Grifflonia simplicifolia (DC BAILL)***	Fabacea	Shrub	Cultivate	Cough sore throat , anaemia, anti-inflammatory;
11	***Harungara madagascariensis (LAM)***	Rutaceae	Tree	Wild	Anaemia; Malaria; anti-inflammatory; infection
12	***Holarrhena floribunda (L. PROTA)***	Apocynaceae	Tree	Wild	Anaemia; Malaria; anti-inflammatory; infection
13	***Jatropha grosssypiifolia.L***	Euphorbiacea	Shrub	Cultivate	Malaria; anaemia; infection scarring
14	***Justicia secunda (VAHL)***	Acanthaceae	Shrub	Wild	Anaemia; Antihypertensive
15	***Khaya senegalensis (DESR A. JUSS)***	Meliaceae	Tree	Wild	Skin infection; Anaemia; Malaria; Infection
16	***Kigelia africana (PROTA)***	Bignoniaceae	Tree	Wild	Delivery infection; sexual weakness; sexual hormone regulator
17	***Morinda lucida L.***	Rubiaceae	Shrub	Wild	Malaria; anaemia; Antimicrobial, infertility Treatment Female
18	***Nauclea latifolia L.***	Rubiaceae	Tree	Wild	Anaemia; Malaria; infection anti-inflammatory;
19	***Parquetina nigrescens (ALZEL)***	Periplocaceae	Liana	Wild	Malaria; anaemia; Eyes pain; kidney pain; delivery
20	***Solanum torvum* Sw.**	Solanoceae	Shrub	Wild	Anaemia; Infection
21	***Spathodea campanulata* (P.Beauv)**	Bignoniaceae	Tree	Wild	Delivery infection; sexual weakness; malaria; prevention of illnesses
22	***Terminalia catapa L.***	Combretaceae	Tree	Wild	Anaemia; Infection; Pain
23	***Xylopia aethiopica (DUM)***	Annonaceae	Shrub	Cultivate	Infection
24	***Zanthoxylum gilletii (DE WILD)***	Rutaceae	Tree	Wild	Anaemia; Malaria; infection antihypertensive; sexual weakness, anti-inflammatory;
25	***Zanthoxylum leprieuri (GUILL)***	Hypericaceae	Tree	Wild	Anaemia; Malaria; infection; antihypertensive; sexual weakness, anti-inflammatory;

N°	Scientific names of plants	Family	Morphology	State of plants	Other therapeutic Practices
26	**Zingiber officinale (Rosc)**	Zingiberacea	Grass	Cultivate	Cough sore throat , Infection

Table 3: Ethnobotanical characteristics

	BOTANICAL NAME	FAMILY	LOCAL NAME	ETHNIC GROUP	PLANT PARTS USED	MODE OF PREPARATION	ADMINISTRATION, DOSAGE AND DURATION OF THE TREATMENT
1	***Parquetina nigrescens (ALZEL)***	Periplocaceae	Ababagnan	Agni	Leaf / Stem	Decoction	Oral, drink three glasses a day indefinitely
	Justicia secunda (VAHL)	Acanthaceae	Modja waka	Baoule	Leaf Stem Bulb		
	Jatropha grosssypiifolia L.	Euphorbiacea	Applopl gna	Agni	Leaf Stem Bulb		
	Afromonum melegueta K.SCHUM)	Zingiberacea	Essa	Agni	Seed		
2	***Kigelia africana (PROTA)***	Bignoniaceae	Singian	Malinke	Stem Bark	Decoction	Oral and enema until healing
	Harungara madagascariensis (LAM)	Hypericaceae	Soulgalani brou	Malinke	Leaf		
	Zanthoxylum leprieuri (GUILL)	Rutaceae	Bakélé	Baoulé	Stem Bark		
	Xylopia aethiopica (DUM)	Annonaceae	Essidian	Agni	Fruit		
3	***Alstonia boanei (De Wild)***	Apocynaceae	Grien	Agni	Stem Bark	Decoction	Oral and enema, drink two glasses a day indefinitely
	Ceiba pentandra (L.GAERTN)	Bonbacaceae	Bana-hiri	Malinké	Stem Bark		
	Holarrhena floribunda (L. PROTA)	Apocynaceae	Sèbè	Malinké	Root Bark		
	Nauclea latifolia L	Rubiaceae	Badi des marais	Francais	Root Bark		
	Zanthoxylum gilletii (DE WILD)	Rutaceae	wô	Agni	Stem Bark		
	Anthocleista djalonensis (AFZEL)	Loganiaceae	Anoubé	Akyé	Stem Bark		
	Afromonum melegueta (K.SCHUM)	Zingiberacea	Essa	Agni	Seed		
	Xylopia aethiopica (DUM)	Annonaceae	Essidian	Agni	Fruit		
4	***Spathodea campanulata (P.Beauv)***	Bignoniaceae	Assrele	Agni	Stem Bark	Decoction	Oral and enema, drink two glasses a day for 1 WEEK

	Blighia sapida (K.D. KOENIG)	Sapindaceae	Kaha yafoufené	Akyé	Stem Bark		
	Afromonum melegueta K.SCHUM)	Zingiberacea	Essa	Agni	Seed		
	Xylopia aethiopica (DUM)	Annonaceae	Essidian	Agni	Fruit		
	Zingiber officinale (ROSC)	Zingiberacea	Doiyiya	Agni	Root		
5	***Ceiba pentandra (L.GAERTN)***	Bonbacaceae	Bana-hiri	Malinké	Stem Bark	Decoction	Oral and enema ; drink two glasses a day for 2 weeks
	Afromonum melegueta (K.SCHUM)	Zingiberacea	Essa	Agni	Seed		
6	***Distemonanthus benthamianus (BAILL)***	Caesalminiaceae	Doukouman	Agni	Stem Bark	Decoction	Oral and enema, drink two glasses a day for three weeks
	Afromonum melegueta (K.SCHUM)	Zingiberacea	Essa	Agni	Seed		
7	***Grifflonia simplicifolia (DC BAILL)***	Fabaceae	Blokotoa	Baoulé	Leaf	Grinding	Cutaneous rub on body until relieved
	Xylopia aethiopica (DUM)	Annonaceae	Essidian	Agni	Fruit		
8	***Khaya senegalensis (DESR A. JUSS)***	Meliaceae	Djara	Malinke	Stem Bark	Decoction	Oral and enema
	Annona senegalensis (PERS)	Annonaceae	Soussoube	Malinke	Stem Bark and leaf		
	Cassia sieberiana (DC)	Caesalpiniaceae	Siadjan lili	Malinke	Stem Bark		
	Afromonum melegueta (K.SCHUM)	Zingiberacea	Essa	Agni	Seed		
	Xylopia aethiopica (DUM)	Annonaceae	Essidian	Agni	Fruit		
9	***Nauclea latifolia L.***	Rubiaceae	Baty	Malinké	Stem Bark and Root	Decoction	Oral and enema, drink two glasses a day for 3 months
	Adenia lobata (JACQ)	Passifloraceae	Gounanfra	Malinké	Stem Bark		
	Afromonum melegueta (K.SCHUM)	Zingiberacea	Essa	Agni	Seed		
	Xylopia aethiopica (DUM)	Annonaceae	Essidian	Agni	Fruit		
10	***Solanum torvum SW.***	Solanoceae	Gnankadrowa	Agni	Fruit	Sauce	Oral always if possible
11	***Terminalia catapa L***	Combretaceae	Cocoma	Agni	Stem Bark and leaf	Decoction	Oral and cutaneous during crises, until relief

	Morinda lucida L	Rubiaceae	Kongroman	Abron	Leaf		

4.5 Antisickling activity of the recorded plants: Besides some ethnobotanical studies carried out in the world, literature presented scientific validation of Antisickling activity concerning some plants recorded in this study. Indeed, the anti-sickling effects of the crude aqueous extract (CAE) of *Xylopia aethiopica* have been investigated. CAEs exhibited a large anti-sickling effect by inhibiting HbSS polymerization to 90%. This CAE was also able to reverse sickled erythrocytes and improve Fe^{2+}/Fe^{3+} ratio 80. Thin layer chromatographic analysis highlighted that CAEs contain some anti-sickling amino acids such as Arg, Tyr and Asp at varying concentrations. The total free amino acid concentrations of the samples revealed high concentrations of 1028 mg. This author's results suggest that when used as spice in food, *Xylopia aethiopica* might be a promising option for the effective management of SCD (Uwakwe *et al.*, 2008). Also, Akakpo-Akue *et al.*, (2018), have studied the reversal activity of the aqueous extract of a multi-plant recipe that has been made up of (*Jatropha grosssypiifolia, Justicia segunda* and *Parquetina nigrescens*). The results showed that to a concentration of 10mg/mL of plant extract, the sickling reversion rate was 80%. Individually, these three plants have also shown antisickling properties. For example, a petroleum ether and aqueous methanol of *Parquetina nigrescens* showed a protective effect on the membrane and an inhibitory action on the hemolysis of red blood cells (Imaga *et al.,* 2010) and many extracts of *Justicia secunda* have been studied by Mpiana *et al.*, (2012). As for *Harungana madagascariensis* Lam. ex. Poir (Hypericaceae), its aqueous and ethanolic extracts display 42% inhibitory of the polymerization and 52% reversal activities of the erythrocytes (Fatokun *et al.*, 2015). Moreover, the antisickling activiy of *Zanthoxylum gilletii* De Wild. *K. senegalensis* were respectively studied by Elekwa *et al.*, (2005) and Fall *et al.,* (1999). As for Mpiana *et al.,* (2007) these authors investigated the anti-sickling activity of *Afromomum albo violaceum, Annona senegalensis and Ceiba pentandra,* and *T. catappa* by Chikezie, (2011).

4.6. Phytochemical and pharmacological characteristics: The two extracts (aqueous and hydro-ethanolic) of the 26 plant species contain all the chemical groups of secondary metabolites (Table 4). Only quinone was not revealed in the majority of the two plant extracts. Both solvents concentrate the secondary metabolite alike. Indeed the presence of phenols is common in most plants. Flavonoids are well known to in influence enzymes activity in several biological processes (Ghedira, 2005). Moreover, the presence of alkaloids is a great therapeutic interest because of their pharmacological and biological properties. Alkaloids could also have anti-inflammatory, antioxidant and antibacterial properties (Karou, 2006). Recently Ngbolua *et al.,* (2015) showed antisickling activity of a poly-terpene (lunaric acid). Indeed, this poly-terpene associated with anthocyanins would prevent the peroxidation of membrane lipids and thus prevent erythrocyte lysis and inhibit the polymerization of haemoglobin S by engaging in a reaction with this protein, which would be competitive. Other authors have shown these same activities of triterpenes such as betulinic, maslinic, oleanolic (Tshibangu, 2011) and ursolic acid (Tshilanda *et al.*; 2015). All the results of the phytochemical screening would partly explain the prescription of these plants as therapeutic means. A drug based on these compounds could provide sickle cell patients with seizure spacing since most of these compounds have anti-inflammatory, anti-analgesic, anti-oxidant, anti-anaemic antisickling, and anti-infectious activity.

Table 4: Table showing phytochemical screening of the 26 plants species selected for the study

Plants \ Secondary metabolites	AQUEOUS EXTRACT							HYDRO-ETHANOLIQUE EXTRACT						
	Sterol / polyterpenes	Polyphenols	Flavonoids	Tannin CAT / GALLI	Quinonic substances	Alkaloids	Saponisides	Sterol / polyterpenes	Polyphenols	Flavonoids	Tannin CAT / GALLI	Quinonic substances	Alkaloids	Saponisides
Adenia lobata (JACQ)	+	+	+	+	-	+	+	+	+	+	+	-	+	
Afromonum melegueta (K.SCHUM)	+	+	+	+	-	+	-	+	-	+	-	-	+	-
Alstonia boonei (De Wild)	+	-	-	+	+	+	+	+	-	-	+	+	+	-
Annona senegalensis (PERS)	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Anthocleista djalonensis (AFZEL)	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Blighia sapida (K.D. KOENIG)	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Casia sieberiana (DC)	+	+	+	+	-	-	+	+	+	+	+	-	-	-
Ceiba pentandra (L.GAERTN)	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Distemonanthus benthamianus (BAILL)	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Grifflonia simplicifolia (DC BAILL)	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Harungara madagascariensis (LAM)	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Holarrhena floribunda(L. PROTA)	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Jatropha grosssypiifolia.L	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Justicia secunda (VAHL)	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Khaya senegalensis (DESR A. JUSS)	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Kigelia africana (PROTA)	+	+	+	+	+	+	+	+	+	+	+	+	+	-
Morinda lucida L.	+	+	+	+	+	-	+	+	+	+	+/-	+	+	-
Nauclea latifolia L.	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Parquetina nigrescens (ALZEL)	+	+	-	+	-	+	+	+	+	+	+	-	+	-
Solanum torvum Sw.	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Spathodea campanulata (P.Beauv)	+	+	+	+	-	+	+	+	+	+	+	-	+	
Terminalia catapa L.	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Xylopia aethiopica (DUM)	+	+	+	-	+	-	+	+	+	+	+	-	-	-
Zanthoxylum gilletii (DE WILD)	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Zanthoxylum leprieuri (GUILL)	+	+	+	+	-	+	+	+	+	+	+	-	+	-
Zingiber officinale (Rosc)	+	+	+	+	-	+	+	+	+	+	+	-	+	-

5 CONCLUSION

The ethnomedicinal investigations conducted out in the eastern of Côte d'Ivoire, in the Indenié-Djouablin region show that 26 species of plants are used by traditional healers to manage sickle cell disease. The drugs (bulb, bark of stem, leaves, flowers, fruits and seeds) are used to make up medication recipes mostly by decoction. There are 3 modes of administration: oral, cutaneous and enema. Drinking is the most used mode of administration. The chemical screening performed on the aqueous and alcoholic extracts of 26 plants species revealed

the presence of alkaloids, saponins, total polyphenols, flavonoids, tannins, quinones, terpenes and steroids. Phenolic and triterpenes compounds were reported to display antisickling activity *in vitro*. Some pharmacological information indicate the valid use of the studied plants by traditional healers in the eastern of Côte-d'Ivoire, to fight sickle cell anaemia. However, further research is needed to study the toxicity, to determinate and isolate the plants active chemical compounds and understand their pharmacological modes of action.

6 ACKNOWLEDGEMENTS

The authors would like to thank the Laboratoires de Biologie et Santé de l'UFR des biosciences et de pharmacognosie de L'UFR des Sciences Pharmaceutiques et Biologiques de l'Université Félix Houphouet Boigny of Cocody as well as the Département de Biologie Végétale de l'UFR des Sciences Biologiques, Université Péléforo-Gbon-Coulibaly, for their availability and assistance in carrying out this work.

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